DOCUMENT RESUME

ED 043 089 24 CG 005 925

AUTHOR	Cox, Richard C.; Wildemann, Carol E.
TITLE	Taxonomy of Educational Objectives: Cognitive Domain. An Annotated Bibliography.
INSTITUTION	Pittsburgh Univ., Pa. Learning Research and Development Center.
SPONS AGENCY	Office of Education (DHEW), Washington, D.C.
REPORT NO	Monogr-1
BUREAU NO	BR-5-0253
PUB DATE	Mar 70
NOTE	54p.
EDRS PRICE	EDRS Price MF-$0.25 HC-$2.80
DESCRIPTORS	*Bibliographies, Classification, *Cognitive Development, *Cognitive Objectives, Cognitive Processes, *Educational Objectives, Literature Reviews, *Taxonomy

ABSTRACT

This represents the latest in a series of efforts, on-going since 1965, to up-date and revise a listing of continuously received literature which pertains to the Taxonomy. (TL)

UNIVERSITY OF PITTSBURGH - LEARNING R & D CENTER

MONOGRAPH 1

TAXONOMY OF EDUCATIONAL OBJECTIVES: COGNITIVE DOMAIN

AN ANNOTATED BIBLIOGRAPHY

RICHARD C. COX AND CAROL E. WILDEMANN

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY

CE 005 925

ED0 43089

ED043089

Taxonomy of Educational Objectives: Cognitive Domain

An Annotated Bibliography

Richard C. Cox

and

Carol E. Wildemann

Learning Research and Development Center

University of Pittsburgh

March, 1970

Published by the Learning Research and Development Center supported in part as a research and development center by funds from the United States Office of Education, Department of Health, Education, and Welfare. The opinions expressed in this publication do not necessary reflect the position or policy of the Office of Education and no official endorsement by the Office of Education should be inferred.

PREFACE

At the 1965 meeting of the American Educational Research Association a small group of individuals met for the purpose of discussing various research activities pertaining to the Taxonomy of Educational Objectives Handbook 1: Cognitive Domain. The participants in this meeting, chaired by David Krathwohl, included the authors of the Taxonomy and approximately fifteen scholars who had either utilized the Taxonomy in their work or had conducted research on the Taxonomy. There was agreement at the meeting that there existed a definite need for communication among persons working with the Taxonomy.

As a first step toward meeting this need, John M. Gordon and I started systematically to search for publications and unpublished reports in order to compile a list of references for dissemination to interested researchers. As this task proceeded it seemed logical to provide a short description of each report so that a prospective user could decide whether or not the reported study would be relevant for his purposes. The result of the first effort at information retrieval was two documents: "Validation and Uses of the Taxonomy of Educational Objectives: Cognitive Domain, A Select and Annotated Bibliography" and "In-Progress Studies and Utilization of the Taxonomy." Both of these documents were mimeographed reports and were disseminated during the month of February, 1966. The documents were sent to all persons contributing references, to the participants of the 1965 meeting, and in answer to any individual requests received during 1966. The response to this first effort was extremely rewarding both in terms of the number of requests and the favorable unsolicited comments.

Another meeting of the Taxonomy group was held during the February, 1966, AERA session. At this time it was heartily recommended that the bibliographies were prepared and disseminated. These

included the studies and in-progress reports that had come to my attention since the original documents were compiled.

With the help of Nancy Jordan Unks, a graduate student in Educational Research, the collection and abstraction process continued. In June, 1967 an annotated bibliography prepared by Nancy Unks and myself was published as Working Paper 13 of the Learning Research and Development Center, University of Pittsburgh.

Following the publication of Working Paper 13 there were many helpful suggestions for yet a further revision. Abstracts and original research reports pertaining to the Taxonomy continued to be received, and these combined with references appearing in Dissertation Abstracts and the Education Index form the basis for the latest updating of the Taxonomy bibliography. Assistance with this 1970 version was provided by Carol Wildemann, a graduate student in Educational Research. As the research dealing with the Taxonomy increases it is inevitable that some relevant studies will have been overlooked in our abstracting process. We apologize and would hope that nevertheless this document will be of value to those interested in the cognitive domain of the Taxonomy.

Richard C. Cox
March, 1970

ANNOTATED BIBLIOGRAPHY

Alberta Department of Education

The following series of pamphlets was developed at the direction of the Alberta Department of Education to encourage teachers to use the Taxonomy in the statement of instructional objectives and construction of classroom tests. In each booklet the Taxonomy is outlined and sample objectives and test items relevant to the specific subject area are presented.

Department of Education, Summary Description of Grade Nine Literature Objectives, Test Items and Blueprint, Edmonton, 1967.

Department of Education, Summary Description of Grade Nine Social Studies Objectives and Items, Edmonton, 1966.

Department of Education, Supplement to Summary Description of Grade Nine Science Objectives and Test Items, Edmonton, 1966.

Department of Education, Supplement to Summary Description of Grade Nine Social Studies Objectives, Test Items, and Blueprint, Edmonton, 1967.

Department of Education, Summary Description of Grade Nine Literature Objectives, Test Items and Blueprint, Edmonton, 1967.

Department of Education, Taxonomy of Language IX Objectives with Illustrative Test Items: A Summary Description, Edmonton, 1968.

Department of Education, Taxonomy of Mathematics IX Objectives with Illustrative Test Items: A Summary Description, Edmonton, 1968.

Department of Education, Taxonomy of English 30 Objectives with Illustrative Test Items: A Summary Description, Edmonton, 1968.

Allen, Graham J. The development of tests for the measurement of cognitive objectives in social studies at the upper primary level. Unpublished masters thesis, University of Melbourne, 1966.

The Taxonomy was used to classify objectives of Social Studies. Tests were then designed to measure these objectives and an attempt was made to use correlational techniques, including factor analysis, to establish some of the properties claimed for the Taxonomy. It was found that sub-tests of items from the same test correlated more highly and were more alike in factor structure than sub-tests of items from different tests which had the same taxonomical classification. Thus the hierarchical structure of the Taxonomy was neither supported nor denied.

Alles, Jinapala et. al. An attempt at restructuring some conceptual frameworks used in curriculum development and evaluation, Working Paper I in Theoretical Constructs in Curriculum Development and Evaluation, Division of Secondary Education, Ministry of Education, Ceylon, 1967.

This working paper examines the emerging trend of theory development and evaluation in the area of secondary education curriculum. After a short review of both the cognitive and affective Taxonomies as meaningful tools in curriculum work, the authors conclude that there is a need for a systematic analysis of the capacity aspects of the Knowledge category for certain purposes.

Anderson, June S. A comparative study of chemical educational material study and traditional chemistry in terms of students' ability to use selected cognitive processes. Dissertation Abstracts, 1965, 25, 5147.

The investigation was designed to determine whether students' abilities to use selected cognitive processes were developed to a different extent when CHEM study, as opposed to traditional chemistry, was the mode of instruction. The selected cognitive processes were the first four categories of the Taxonomy and multiple choice tests based on these levels were constructed. Factor analyses included in the study tend to support the hierarchical nature of the Taxonomy.

Anderson, Ronald D. Formulating objectives for elementary science, Science and Children, 1967, 5, 20-23.

Discussion centers around the importance of formulating behavioral objectives for an elementary school Science curriculum. A procedure for writing good objectives is discussed with reference to the basic ideas presented by Mager. The Taxonomy is described and suggested as a tool for critically examining objectives to see whether they reflect all of the desired outcomes of Science instruction.

Avital, Shmuel M. Higher level thinking in secondary school students' attainment in mathematics, Unpublished Doctoral Dissertation, University of Toronto, 1967.

The comprehensiveness and adaptability of the Taxonomy to various curricula and courses is an often examined question. Investigated here is whether it could be adapted to a specific secondary level Mathematics curriculum. Questions examined in the study are: (1) Is it possible to determine psychological mechanisms which underly performance of Mathematical tasks classified under the various Taxonomy categories?; (2) Is it possible to

obtain high rater agreement on a classification of a set of items dealing with Mathematical tasks, according to the various levels of the Taxonomy?

Ayers, J. Douglas. Justification of Bloom's Taxonomy by factor analysis. Paper presented at the meeting of the American Educational Research Association, Chicago, February, 1966.

Factor analyses were conducted on a 40 item multiple-choice test. The items were classified according to the Taxonomy in order to provide a criterion for rotation of factors and to check on the adequacy of the classification. The hierarchical structure of the Taxonomy was supported. The study suggests the analyses of longer tests which utilize more of the Taxonomy categories.

Ayers, J. Douglas. Developing descriptions of objectives and test items. Paper presented at International Workshop, Possibilities and Limitations of Educational Testing, Berlin, Germany, May 1967.

According to the author, this paper might well be titled "Adapting Bloom's Taxonomy to a Subject Area or Discipline at the State or Local Level." It attempts to explain some of the factors which have affected the slow acceptance of the Taxonomy. There is also a report on the procedures that were developed in Alberta, Canada, for putting in the hands of teachers, revised and expanded descriptions of Bloom's Taxonomy in each of a number of subject areas. These descriptions which were then available in three subject areas were developed by classroom teachers and faculty of Education personnel at the University of Alberta. (See also Alberta, Department of Education).

Baughman, Gerald D. Germane material criteria for promoting the general heuristic cognitive theme of the Cambridge conference on school mathematics. Dissertation Abstracts, 1968, 29A, 506. Also published as Preparing for the next mathematics revolution, Journal of Secondary Education, 1969, 44, 182-186.

A set of criteria was proposed for the development of problem situations in elementary school Mathematics which promote use of general heuristic cognitive patterns. Polya's How to Solve It was used to describe general heuristic patterns, and the Taxonomy was selected as the basis for describing the intellectual abilities used in the heuristic reasoning process.

Baughman, Gerald D., & Mayrhofer, Albert. Leadership training project: a final report. Journal of Secondary Education, 1965, 40, 369-372.

During the first four meetings of the Leadership Training Project, twenty-five people in positions of active responsibility for curriculum design, construction and evaluation studied and discussed the Taxonomy. The next four meetings were conducted by speakers who discussed the implications of the Taxonomy for education. Subsequent meetings included a curriculum theorist's view on the Taxonomy and discussions of student typologies, curriculum, and guidance in reference to the Taxonomy. During the first and last meetings the participants were asked to list objectives for a K-6 program. Of the 64 objectives suggested in the first meeting, only 41 (64 percent) could be classified according to the Taxonomy categories. In the final meeting the same participants listed 306 objectives, with 256 (84 percent) classifiable according to the Taxonomy.

Bensen M. James. Do your students learn - or memorize? Industrial Arts and Vocational Education, 1967, 56 (8), 24-25.

The Taxonomy is described and discussed in relation to the field of industrial education. The author suggests that there needs to be an intentional provision for studying industry at the different taxonomic levels and discusses how course content, student activities and outcomes, teaching methods and materials, as well as time and place of instruction, are affected by and reflected in the levels of the classification of course objectives.

Bialek, Hilton M. A measure of teachers' perceptions of Bloom's educational objectives. Paper presented at the meeting of the American Educational Research Association, New York City, February 1967.

Teachers' rankings of the importance of the Taxonomy objectives were compared with the original taxonomic ranking. It was hypothesized that since the objectives in one class are suppose to make use of, and be built upon, the behaviors found in the preceeding classes in the Taxonomy, the "basic" objectives would be perceived as more imperative than the higher-ordered ones. Findings included: (1) there is only a rough degree of agreement between teachers' perceived importance and Bloom's theoretical hierarchy; (2) the respondents' reference group, slow, average or accelerated learner, has a great effect on the perceived importance of the objectives. The author concludes that teachers are not sufficiently aware of levels of cognitive functioning, which makes the dissemination and utilization of a systematic, ordered curriculum difficult.

California Project Talent

The Taxonomy was utilized to a great extent in the California Project Talent endeavor. It was especially helpful in correlation of curriculum content with intellectual operations and products. In the final report it is stated that perhaps the most important long term outcome of the project will be the demonstration of the feasibility of applying theoretical models such as the Taxonomy to the construction of curriculum content.

Actually there are too many documents from California Project Talent to be referenced and abstracted here. The following list is intended to be representative of references mentioning the Taxonomy.

Plowman, Paul D. and Rice, Joseph P. Final Report, California Project Talent, California State Department of Education, Sacramento, California, 1969.

Being the final report, this document is probably the first place to look for references to Taxonomy based aspects of California Project Talent. A quick examination of the selected position papers and references will give the reader some feeling for the type of approach taken by Project personnel with respect to the Taxonomy.

Plowman, Paul D. and Rice, Joseph P. Revised Guidelines for Establishing and Evaluating Programs for Mentally Gifted Minors, California State Department of Education, 1964.

Of special note in this document is Appendix B, Models for Curriculum Development and Evaluation. Two of the articles in this Appendix describe models specifically based upon the Taxonomy.

California Project Talent, Identification Case Study, California State Department of Education, 1964.

Part V, Additional Resources and Instruments, cites the Taxonomy as an experimental approach which is an important conceptualization that broadens the scope of intellectual behaviors. One of the rating scales which serves as an example of idea implementation needed in public education is an adaptation of the sub-categories of the Taxonomy.

California Project Talent Film Series I: "The Development of Scientific Discovery, Methodology and Investigation Through a Study of Graphic Representation of Statistical Information."

Film no.

1. Knowledge
2. Comprehension
3. Application
4. Analysis
5. Synthesis
6. Evaluation

Mary P. Broderick, Enrichment Demonstration Consultant
Distributed by: Great Plains Instructional Television
Library University of Nebraska, Lincoln, Nebr., 68408

The six filmed lessons based on the Taxonomy: Cognitive Domain are part of a series of fourteen developed by California Project Talent to demonstrate "enrichment programs for intellectually gifted students". The series of lessons, each one-half hour in length, is designed for teacher education. In the first six, the application of the Taxonomy to the study of mathematics is depicted in actual classroom situations.

Carlson, Jerry S. and Ryan, Frank L. Levels of cognitive functioning as related to anxiety, Journal of Experimental Education, 1969, 37 (4), 17-20.

The relationship between anxiety and performance at different levels of cognitive functioning was investigated with samples of university and high school students. Four evaluative instruments were constructed to reflect the Taxonomy categories of Knowledge, Comprehension, Application, and Analysis. Anxiety was measured by the Autobiographical Survey developed by Sarason. Significant negative correlations between test anxiety and Knowledge, and test anxiety and Comprehension were found for the university sample. The results are discussed in terms of interfering effects to task performance that anxiety may produce when the examinee must rely on memory.

Carroll, Charles R. Application of the "Taxonomy of Educational Objectives" to alcohol education. Dissertation Abstracts, 1966, 26, 3693.

Objectives of alcohol education were classified according to the Taxonomy. The appropriateness of the objectives for general education was then judged by ten alcohol education specialists and ten school health educators. The two groups of judges had 68 percent agreement on the acceptance or rejection of each objective, but disagreed about their degree of importance. This may have been because of judges' individual values and different interpretations of the Taxonomy, general education, and the importance of alcohol education. It was concluded that the Taxonomy can be a useful logical schema for organizing alcohol education.

Cox, Richard C. Item selection techniques and evaluation of instructional objectives. Journal of Educational Measurement, 1965, 2, 181-187.

An item pool of 379 multiple-choice items was classified using the Taxonomy categories. From this item pool the 100 most discriminating items were examined in order to determine the effect that statistical item selection has on the final form of a test as compared with the original item pool. Findings indicate that statistical selection of items has a biasing effect on tests in terms of percentage of items in each Taxonomy category. The proportion of items in the selected tests (100 items) which measure certain instructional objectives is unlike the proportion of items in the total item pool. Statistical selection of items from the total item pool appears to operate differentially for male and female groups.

Cox, Richard C. An overview of studies involving the "Taxonomy of Educational Objectives: Cognitive Domain" during its first decade. Paper presented at the meeting of the American Educational Research Association, Chicago, February 1966.

The impact of the Taxonomy is assessed with reference to four criteria. In order to be considered a useful and effective tool, the Taxonomy must be (1) communicable, (2) comprehensive, (3) stimulating to thought concerning educational problems, and (4) acceptable and useful to workers in the field. Studies are cited which exemplify how well the Taxonomy meets each of these criteria. Considerable discussion is devoted to educational problems brought to light by the Taxonomy. As a whole the Taxonomy appears to meet all four criteria successfully.

Crawford, William R. A validation of the structure and generality of A Taxonomy of Intellectual Processes. Dissertation Abstracts, 1966, 27A, 947.

The purpose of this study was to investigate empirically the internal structure of tests designed to measure the processes defined in A Taxonomy of Intellectual Processes, (see McGuire, 1963). Questions for which data and discussion are provided include: (1) Are examination items constructed to measure the same intellectual processes, statistically homogeneous?; (2) Are the intellectual processes general over academic disciplines?; (3) Are the intellectual processes hierarchical?; (4) Is there a relationship between the complexity of an intellectual process and the difficulty of the items constructed to measure it?

Crawford, William R. Item difficulty as related to the complexity of intellectual processes. Journal of Educational Measurement, 1968, 5, 103-107.

There has been a lot of argument that test items which measure more complex processes (like those included in the higher categories of the Taxonomy) are more difficult than items measuring the less complex processes. In this study multiple-choice items were constructed to measure the specific intellectual processes defined in A Taxonomy of Intellectual Processes, (see McGuire, 1963). Results indicated no relationship between the complexity of intellectual processes and the difficulty of items which purportedly measure them.

Davis, O. L. Jr. and Hunkins, Francis P. Textbook questions: what thinking processes do they foster?. Peabody Journal of Education, 1966, 43, 285-292.

The Taxonomy was used in judging the cognitive emphasis of selected fifth-grade Social Studies textbook questions.

Experienced teachers categorized questions from three texts according to Taxonomy classes and subclasses. Of 732 questions, 87 percent dealt with Knowledge, 73 percent falling into the category, knowledge of specifics. Of major note is the observation that in these three textbooks, none of the questions required analytic thinking, one required pupils to engage in synthesis, and only two questions necessitated evaluative thinking. Implications and suggestions for teachers of Social Studies are discussed.

Davis, O. L. Jr. and Tinsley, Drew C. Cognitive objectives revealed by classroom questions asked by social studies student teachers. Peabody Journal of Education, 1967, 45, (1), 21-26.

The Taxonomy was applied to an analysis of questions in classroom interaction. A Teacher-Pupil Question Inventory was developed, with seven of the nine categories based on the Taxonomy and the formulation of Sanders (1966). Memory was the major cognitive objective apparent in teachers' and pupils' verbal questions in 44 Social Studies classrooms. The authors suggest that (1) more deliberate attention to different cognitive objectives in Social Studies' classrooms is necessary, and (2) specific understandings and skills of classroom questioning need major attention in teacher education.

Doak, E. Dale. Toward a strategy for classroom discussion. Journal of Secondary Education, 1969, 44, 62-64.

The author is concerned with the development of higher order thinking through classroom discussion. He briefly outlines the Taxonomy and suggests that it may be viewed as representative of the levels of thought that may be present in the classroom. A previous study by the author indicated that upward of 90 percent of classroom verbalization was at the Knowledge and Comprehension levels of the Taxonomy.

Doherty, Victor W. Procedure for growth, Educational Leadership, 1965, 23, 247-249.

An in-service education program developed by the Portland Public School System is suggested as a prototype for other community schools. Classroom teachers engaged in defining instructional objectives and constructing workshops and courses based on the objectives. Exploration was made to see whether material in the Taxonomy could play a supporting role in the work of the course development committees. The author concludes that most classroom teachers have had insufficient experience with the process goals found in the Taxonomy to use them in organizing teaching, but that given time and more familiarity with the Taxonomy this approach may gain more favor.

Dressel, Paul L. and Nelson, Clarence H. Questions and problems in science. Test Folio No. 1. Cooperative Test Division, Educational Testing Service, Princeton, New Jersey, 1956.

Examinations submitted by Science teachers were separated according to their relevance for the biological and physical sciences. The items in each test were then classified using the subcategories of the Taxonomy, in order to provide a test bank of science items.

Drumheller, Sidney J. A model for applying the Bloom Taxonomy of educational objectives in curriculum design. National Society for Programmed Instruction Journal, 1957, 6, (5), 10-13.

The author proposes a model for using a modified structure of the Taxonomy in the design of curricula and self-pacing teaching materials, and in the classroom by the teacher engaging in long and short range planning. A procedure is provided for identifying long range behavioral goals, analyzing these goals in terms of the Taxonomy, and then placing them at the appropriate course, unit, sub-unit or lesson levels.

Elliott, C. B., Merrifield, Philip R. and Davis, O. L. Jr. Cognitive dimensions of lesson objectives set by secondary student teachers. Paper presented at the meeting of the American Educational Research Association, Chicago, February 1966.

also

Elliott, C. B. Cognitive dimensions of lesson objectives set by secondary student teachers. Unpublished masters thesis, Kent State University, 1965.

This study investigates the feasibility of developing a procedure enabling educators to utilize the Taxonomy in evaluating lesson plan objectives. The study explores (a) using the Taxonomy to analyze the lesson objectives of student teachers; (b) using judges to independently catagorize these objectives according to a prescribed graphic scaling format based on the Taxonomy; and (c) determining which of two such formats was most practicable. Correlational analyses of data failed to support the hypothesized inter-rater agreement and reliability. The data also failed to support the hypothesis that the level of raters' prior knowledge of the use of the Taxonomy makes a difference in their classification.

Ellis, John K. The application of the "Taxonomy of Educational Objectives" to the determination of objectives for health teaching. Dissertation Abstracts, 1964, 25, 1782.

The Taxonomy was utilized to identify different levels of thinking in relation to specific health content and to help select objectives and content for health teaching. The Taxonomy was the framework used to generate 354 objectives. The major conclusion regarding the Taxonomy purports that the categories are applicable to the field of health education in helping to define substantive content and objectives.

Farley, George T. Increasing the cognitive level of classroom questions: an application of Bloom's Taxonomy of educational objectives. Dissertation Abstracts, 1968, 29A, 1150-1151.

The study was conducted to determine if: (1) student-teachers who had received instruction in the use of the Taxonomy would operate in the classroom at a higher cognitive level than student teachers who had not; (2) trained observers and regular teachers could correctly identify the cognitive classroom behavior level stimulated by the classroom instructor. One conclusion was that student-teachers who employ the Taxonomy as a teaching tool will achieve higher cognitive behavior in the classroom.

Gagné, Robert M. The analysis of instructional objectives for the design of instruction. Paper presented at the National Symposium on Research in Programmed Instruction, Washington, D. C., 1963. Also in Glaser Robert (ed.) Teaching Machines and Programmed Learning, II. Washington: National Education Association of the United States, 1965, pp. 21-65.

The Taxonomy is suggested as a guide for curriculum construction. The Taxonomy can be useful at the more abstract levels of curriculum construction but a more specific model is required to guide the selection of instructional materials. A reformulation of the objectives using test items as a basis would help in the development of a specific model.

Harrison, J. Ernest. Achievement of selected types of educational objectives through use of programmed materials and the relationship between this achievement and selected aptitudes for learning. Dissertation Abstracts, 1966, 26, 157.

The differential effect of programmed and conventional material on the achievement of educational objectives in junior high school science was investigated. Questions on the cooperative General Science Test were categorized

according to three levels of the Taxonomy, Knowledge, Comprehension, and Application. The data indicated that students using programmed materials achieved selected educational objectives as well as those using conventional materials, and also that programmed materials can be used effectively to teach objectives more complex than the accumulation of basic knowledge.

Herron, J. Dudley. Evaluation and the new curricula. Journal of Research in Science Teaching, 1966, 4, 159-170.

A modern Chemistry curriculum (CHEM) and a conventional Chemistry course were compared in terms of the gain in cognitive abilities exhibited by the students. A Chemistry test based on the six categories of the Taxonomy was constructed and administered to a sample of students stratified by ability level. Validity of the instrument was investigated by having five individuals knowledgable in the field classify the items according to the Taxonomy. Perfect agreement was attained on 33 of the 83 items and when differences occurred they normally represented a deviation of only one level from the mode. The author suggests that tests based on the Taxonomy might well afford a tool through which a more complete description of mental competencies developed by various courses may be obtained.

Hughes, Ruth P. and Nelson, Helen Y. Measuring relationships among and between cognitive and affective behaviors in a controlled learning situation. Paper presented at the meeting of the National Council on Measurement in Education, Minneapolis, March 1970.

This study was designed to answer the following questions: (1) Are the affective and cognitive Taxonomies reasonable tools for use in the statement and measurement of objectives?; (2) Is the cognitive Taxonomy cumulative in Social Science subject matter?; (3) Is performance at various cognitive levels affected by intelligence?; (4) What is the relationship between the affective and cognitive domains? Achievement tests based on the first three levels of the

cognitive Taxonomy were developed for use in high school Home Economics classes. Guttman simplex analysis supported the postulated cumulative nature of the cognitive domain. A low, positive relationship between student achievement on test items and expressed attitudes toward the topics study was found.

Hunkins, Francis P. Bloom's Taxonomy as a test construction guide. Ideas Educational, The Kent State University School, 1966, 4, (2), 13-16.

The Taxonomy has been suggested as a guide for the development of behavioral objectives and for designing test items consistent with these objectives. The utilization of the Taxonomy is discussed with reference to the construction of multiple-choice test items. It is pointed out that some of the categories of the Taxonomy, not necessarily the highest levels, present some unique difficulties in writing of test items.

Hunkins, Francis P. The influence of analysis and evaluation questions on critical thinking and achievement in sixth grade social studies. Educational Leadership, 1968, 25, 326-332.

This study attempts (a) to determine if the dominant use of Analysis and Evaluation questions in Social Studies text-type materials would stimulate the development of pupils' critical thinking in sixth grade Social Studies; and (b) to discover if this emphasis would improve achievement in Social Studies. Major conclusions of the study relevant to the Taxonomy were as follows: (1) there were no significant differences in the critical thinking abilities among pupils using materials with question emphasis on Analysis and Evaluation and pupils using materials with question emphasis on Knowledge; (2) pupils receiving Analysis and Evaluation type questions had significantly higher scores in Social Studies achievement than did pupils receiving Knowledge type questions.

Irwin, Claire and Reitz, William. Functional competencies of undergraduate students in the humanities. Scientia Paedagogica Experimentales, 1967, 3, 143-177. Also, paper presented at the meeting of the American Educational Research Association, Chicago, February 1963.

This study was designed to investigate the "functional residue" of the humanities in the experiences of undergraduate college students as evidenced by a critical incident measurement technique. Students' responses were classified according to the Taxonomy processes they represented. The cognitive structure of humanities content was described both a-priori and on the basis of responses. Relationships between types of responses and certain characteristics of the respondents were also investigated using chi-square techniques. A general conclusion was that more attention should be given to development of skills in the upper taxonomic categories in the college curriculum.

Jarolimek, John. The Taxonomy: guide to differentiating instruction. Social Education, 1962, 26, 445-447.

The Taxonomy is suggested as a model in planning for differentiating instruction in elementary social studies. The teacher can prepare the various categories in chart form to assist in (a) the planning of a unit; (b) the specification of objectives; (c) the diagnosis of student weaknesses; (d) the planning of appropriate learning activities; and (e) the presentation of a highly diversified attack on the study of problems.

Johnson, Stuart R. Relationships among cognitive and affective outcomes of instruction. Dissertation Abstracts, 1967, 27A, 3724.

The cognitive and affective Taxonomies were used in the development of an instrument for high school Chemistry courses consisting of 40 cognitive items with an affective response scale attached to each. The cognitive items

were selected to represent the first four levels of the cognitive Taxonomy. Two questions were posed in the study: (1) What relationships exist between cognitive and affective outcomes of instruction?; (2) Are cognitive tasks, arranged by Taxonomy level, differentiable and hierarchically related? The study revealed only a small relationship between cognitive achievement and enjoyment of the cognitive task and only weak support was provided for the hierarchical nature of the cognitive Taxonomy. A suggestion was made to attempt validation of the cognitive Taxonomy by use of physiological indices of cognitive involvement.

Kellogg, Ralph E. An American History Test Bank, San Diego County Secondary Curriculum Council, 1964.

A collection of American History test questions was compiled by the committee to demonstrate how student achievement might be evaluated at several cognitive levels. The paper is intended as a model and working paper for teachers in San Diego County.

See also, Lessinger (1963) and Metos, et. al. (1966).

Kilpatrick, Jeremy. Cognitive theory and the SMSG program. Journal of Research in Science Teaching, 1964, 2, 247-251.

An interim report is presented on the use of the Taxonomy in devising mathematics tests for all cognitive levels in grades K-12. The tests will be further developed and used for assessing Math abilities and cognitive styles of attacking problems as part of the National Longitudinal Study of Mathematical Abilities.

Klein, Minnie F. Evaluation of instruction: measurement of cognitive behavior as defined by the "Taxonomy of Educational Objectives". Dissertation Abstracts, 1965, 26, 158.

This study investigated whether a particular definition of cognitive behaviors could be elicited and detected in seven through nine year old children. Cognition was defined by the 21 behaviors outlined in the Taxonomy. An objective test based on these behaviors was developed as the means for eliciting and detecting the behavior. Of specific interest was the following hypothesis which was tentatively accepted after the data analysis: a paper-and-pencil instrument can be developed for the age range of seven, eight and nine which will measure discretely all the behaviors at each level as defined by the Taxonomy.

Klinchman, Evelyn. The BSCS grid for test analysis. BSCS Newsletter 19, The Biological Sciences Curriculum Study, Boulder, 1964, 17-21.

The Biological Sciences Curriculum Study's adaptation of the Taxonomy for examination of tests to determine if they actually incorporate BSCS aims is presented. Two BSCS tests and the Cooperative Biology Test were analyzed. A difficulty encountered was that of classifying test items when the relevent prior learning experiences of the students in unknown.

Krathwohl, David R. The "Taxonomy of Educational Objectives" - its use in curriculum building. In C. M. Lindvall (ed.) Defining Educational Objectives, Pittsburgh: University of Pittsburgh Press, 1964, 19-36.

The nature of the Taxonomy as an "educational - logical - psychological classification system" is described and its value in curriculum construction discussed. It is suggested as a basis for (1) working with objectives with a specificity not usually employed; (2) providing a range of possible outcomes which can be adopted as curricular goals; (3) com-

paring objectives of different curricula; (4) suggesting a hierarchy of learning experiences; and (5) analyzing test items in reference to curriculum objectives.

Krathwohl, David R. Stating objectives appropriately for program, for curriculum, and for instructional materials development. Journal of Teacher Education, 1965, 16, 83-92.

The use of educational objectives at several levels of detail in the educational process is discussed. The Taxonomy is described as a framework which can facilitate the development and analysis of objectives at the intermediate level. The Taxonomy is suggested as a relatively concise model for the analysis of objectives. It may provide a panorama of objectives to be explored, a basis for precise comparison, and it may suggest a readiness relationship existing between lower and higher level objectives in the hierarchy.

Kropp, Russell P., Stoker, Howard W. and Bashaw, W. L. The validation of the "Taxonomy of Educational Objectives." Journal of Experimental Education, 1966, 34, 69-76.

The major problems that may be encountered in an attempt to validate the Taxonomy are discussed in order to provide an investigator with some insight into some theoretical and practical problems.

a. The choice of a response measure is a critical problem. A process response measure requires detecting whether or not the student uses the intended process, whereas a product response measure requires detecting whether or not the student selects the keyed response.

b. The test content and format are the two major factors to be considered when choosing the conditions under which the response measure will be collected.

c. Ambiguity of the Knowledge category of the Taxonomy may indicate that this category is two-dimensional. A careful analysis of this area should precede any validation study.

d. Statistical difficulty created by the hierarchical nature of the Taxonomy demands the selection of appropriate test construction methodology and perhaps the development of new statistical models.

Several studies which would relate scores on Taxonomy type tests to certain criterion measures are suggested.

Kropp, Russell P., Stoker, Howard W. and Bashaw, W. L. The construction and validation of tests of the cognitive processes as described in the "Taxonomy of Educational Objectives." Cooperative Research Project No. 2117. Institute of Human Learning and Department of Educational Research and Testing, Florida State University, 1966.

A three-year long series of studies designed to explore the construct validity of the Taxonomy is reported. The three questions under consideration were the following:

1. Can empirical evidence be found to support or refute the imputed hierarchical structure?

2. Can empirical evidence be found to support or refute the imputed generality of the several cognitive processes?

3. Can each level of the structure be explained by more elemental cognitive aptitudes, and, if so, do the combinations or numbers of them change systematically from one major level to the next?

The hypothesis of inverse relationships between mean performance and taxonomic level was generally supported; the data gave evidence for the imputed hierarchical structure of the Taxonomy. The hypothesis of the generality of process was not clearly supported; the data suggest that the specific test score being analyzed is determined by a highly complex interaction of content and process. Investigation of the third question revealed the obvious need for more highly developed analytic techniques and data from more refined taxonomy-type tests.

Lawrence, Gordon D. Analysis of teacher-made tests in social studies according to the "Taxonomy of Educational Objectives". (Clarmontiana Collection) On file at Honnold Library of the Claremont Colleges, Claremont, California, 1963.

Tests and final examinations in Social Studies were collected from 63 high schools in Southern California. From 74 randomly selected tests, 4562 items were classified according to the Taxonomy subcategories. The data were analyzed with respect to four subject fields: Geography, American History, World History and U.S. Government. Resultant data indicated (1) approximately 98 percent of the items were classified in the Knowledge category and 75 percent of these were classified under the Knowledge of Specific Facts subcategory; (2) the 2.3 percent of the items which fell above the Knowledge category were classified in only two of the upper five categories, Comprehension and Application; and (3) the four subject fields had a slightly different pattern of distribution of items.

Lessinger, Leon M. Test building and test banks through the use of the "Taxonomy of Educational Objectives". California Journal of Educational Research, 1963, 14, 195-201.

The Taxonomy can be utilized to upgrade classroom test construction. Teachers in the Grossmont Union High School District are instructed in the use of the Taxonomy and, subsequently, use the categories to aid in construction and revision of test questions. A by-product of this approach has been the collection of 566 carefully prepared geography test items. Similar test banks are being prepared in English, Social Studies, foreign languages and Math.

See also Kellogg (1964) and Metos et. al. (1966).

Levin, Alvin I. The use of taxonomic programming as applied to the teaching of fractions in grade five. Unpublished Doctoral Dissertation, University of California, Los Angeles, 1968.

In this study of teaching fifth-grade students the addition of fractions and their application to problem solving and evaluation tasks, the Taxonomy was used as a reference point in a variety of ways. First, it was used as a guide in the formulation of specific and measurable objectives applicable to the task. The categories of the Taxonomy also served as a guide in the development of programmed text materials. Finally, it was utilized in the planning and construction of the criterion measure, the Taxonomic Skills Achievement Test.

Lockhead, Ian C. Teacher-made tests. Virginia Journal of Education, 58, (7), 15-17.

As assessment of teacher-made tests in use in public high schools throughout Virginia is reported. The Taxonomy was employed as a model for the classification of over 14,000 test items. Slightly more than 70 percent were classified as Knowledge items, and of this 70 percent more than half were in the lowest subdivisions. The author encourages teachers to reappraise the methods by which they measure their course objectives.

Original findings reported in: Hedges, W. D., McDougall, M. and Lockhead, Ian C. Teacher-made Science tests in selected Virginia high schools. Division of Educational Research, University of Virginia, 1964.

Lombard, John W. Preparing better classroom tests. The Science Teacher, 1965, 32, (7), 33-38.

The construction of better classroom tests may be realized using the Taxonomy as a functional guide. General types of Science questions which test the six categories of cognitive objectives are suggested as

prototypes for many specific items in different subject-matter areas.

The distinction between the categories of the Taxonomy is not crucial since the purpose of the outline is to help in avoiding undue emphasis on certain categories. Also, the difficulty of an item is not necessarily related to its classification. There is a spread of difficulty levels within each category.

Lombard, John W. and Owen, William B. Objectives of Science Education, Chicago: Science Research Associates, 1965.

Under contract to the Exploratory Committee on Assessing the Progress of Education, an extensive compilation was made of current objectives of Science education. The objectives were classified according to the Taxonomy, Handbook 1 and Handbook 2, since they cut across both the cognitive and affective domains. The objectives are being used in developing test items to form the basis of the national assessment of education in Science.

Marksberry, Mary Lee et. al. The cognitive objectives in the elementary education blocks and teacher behaviors, in The Teacher Education Project of the School of Education, Final Progress Report, University of Missouri at Kansas City, 1967, 120-138.

In this project the Taxonomy was used to classify objectives for the elementary education blocks, and as a basis for the development of an instrument to analyze verbal behavior through tape recordings. The resultant instrument called An Analysis Chart for Evaluating the Verbal Behavior of Teachers contains the six major classifications included in the Taxonomy. Under each classification, activities are given which might be demonstrated in elementary classrooms with examples of verbal behavior illustrating these activities.

Marksberry, Mary Lee, McCarter, Mayme and Noyce, Ruth. A study of the relationship of classroom verbal behavior of first-year teachers and the suggestions for verbal behavior given in teachers' editions of tests, in The Teacher Education Project of the School of Education, Final Progress Report, University of Missouri at Kansas City, 1967, 139-146.

A utilization of An Analysis Chart for Evaluating the Verbal Behavior of Teachers (see above reference) is described.

Marksberry, Mary Lee, McCarter, Mayme and Noyce, Ruth. "Relation between cognitive objectives from selected texts and from recommendations of national committees. The Journal of Educational Research, 1969, 62, 422-429.

Cognitive objectives in textbooks from four curriculum areas were compared with cognitive objectives from national committees and with questions and activities suggested by teachers' editions of these textbooks. The textbook objectives, questions and activities were categorized according to the Taxonomy. The data point to inconsistencies between objectives implied by selected national committees and objectives stated by the writers of the textbook. The implications from the national committee reports are that the entire range of problem-solving skills should be taught at all levels of the elementary school. Relatively minor emphasis, however, was placed by textbook writers on Analysis, Synthesis, and Evaluation objectives and the writers of teachers' editions are not fully utilizing the objectives stated by textbook authors.

Mau, Helen D. An investigation of cognitive objectives for college undergraduate home management programs. Dissertation Abstracts, 1965, 26, 1017.

A procedure which uses the Taxonomy for the development of cognitive objectives for undergraduate home management courses is described. A list of 50 objectives, each adapted from Taxonomy statements, was presented as a rating sheet to 279 undergraduate home management professors. Analysis of the results indicated that 17 of the 50 objectives were rated essential by a majority of the sample. Although Application objectives were rated as the most essential class, the Knowledge class was rated on the average more essential than all the other classes combined. A set of 18 cognitive objectives for undergraduate home management courses was formulated by revising the statement of highest ranking essential objectives.

McFall, Robert W. The development and validation of an achievement test for measuring higher level cognitive processes in general science. Journal of Experimental Education, 1964, 33, 103-106.

An achievement test was constructed to identify and evaluate the ability to recall specific material and to deal with higher level cognitive tasks. The six objectives of the Taxonomy were grouped into two major areas, recall and higher mental processes, and used as a basis for developing test items. A procedure was introduced to facilitate the establishment of concurrent validity for this type of measuring instrument.

McGuire, Christine. Research in the process approach to the construction and to analysis of medical examinations. National Council on Measurement in Education Yearbook, 1963, 20, 7-16.

The following adaptation of the Taxonomy is used to examine the reproducibility and significance of process analysis of medical examinations:

TAXONOMY OF INTELLECTUAL PROCESSES

1. Items testing predominantly the RECALL of isolated information.
2. Items testing the RECOGNITION OF MEANING. (Comprehension)
3. Items requiring the student to SELECT A RELEVANT GENERALIZATION for explaining specific phenomena.
4. Items requiring the student to make SIMPLE INTERPRETATIONS OF DATA.
5. Items requiring the student to APPLY PRINCIPLES to situations of a FAMILIAR TYPE.
6. Items requiring the student to APPLY PRINCIPLES to situations of an UNFAMILIAR TYPE.
7. Items requiring the EVALUATION (including analysis) of a TOTAL SITUATION.
8. Items requiring SYNTHESIS of data into an original and meaningful whole.

Three independent raters classifying each question in the 1961 National Board Examinations in their specialty agreed unanimously on 61 percent of 683 items rated. Two or more raters agreed on 93 percent of the items.

In order to achieve better congruence with the objectives of medical education the following revision of the original Taxonomy of Intellectual Processes is suggested:

1.0 Knowledge
2.0 Generalization
3.0 Problem Solving of a Familiar Type
4.0 Problem Solving of an Unfamiliar Type
5.0 Evaluation
6.0 Synthesis

Conclusions include: (a) process analysis yields reproducible results when applied to medical examinations; (b) medical examinations can reliably test the complex intellectual processes; and (c) medical examinations constructed according to process specifications reveal behavior patterns which tend to support the basic hypothesis in terms of which the Taxonomy has been developed.

McGuire, Christine. A process approach to the construction and analysis of medical examinations. The Journal of Medical Education, 1963, 38, 556-563.

Process approach is defined as the description of an examination in terms of required intellectual activity of the examinee. An exploratory investigation of process analysis applied to the evaluation of medical education programs suggests: (a) that certifying examinations currently employed measure chiefly recall of isolated information; (b) that reliable examinations of more complex intellectual processes can be designed; and (c) that varied patterns of student behaviors are revealed in examinations constructed by the process approach.

McGuire, Christine. The process approach to evaluation of medical curricula: theory and practice. Paper presented at the Conference on Medical Education sponsored by the South African College of Physicians, Surgeons and Gynecologists and the Medical Association of South Africa, Durban, South Africa, July 1964.

The Taxonomy of Intellectual Processes is described and discussed as a tool in the evaluation of medical curricula. New approaches in both individual and program assessment at several levels of medical education are suggested. (See other articles by McGuire for details of the process approach and results of research studies.)

Metos, Thomas H., et. al. Developing an American history test bank. Journal of Secondary Education, 1966, 41, 105-110.

A brief summary is presented of a project developed by the San Diego county Department of Education in 1963-64 to develop evaluative instruments based on the conceptual approach for use by American History teachers. During an inservice program, teachers constructed questions representative of each of the six levels of the Taxonomy. Questions indicative of those in the resulting test bank are presented for each of the cognitive levels. Possible relationships of the Taxonomy to six elements of instruction — teachers, students, methods, materials, times, and places — are also suggested.

See also, Lessinger (1963) and Kellogg (1964).

Michael, Joan J. Structure of intellect theory and the validity of achievement examinations. Educational and Psychological Measurement, 1968, 28, 1141-1149.

The author surveys briefly the present status of achievement tests, discusses critically the implications of this status, and sets forth some proposals for the role of Guilford's structure of intellect theory in achievement testing. In reference to the Taxonomy, it is proposed that employing the structure of intellect model to validate the objectives. It is suggested that for each of the six Guilford products (units, classes, relations, systems, transformations, implications) a model be constructed with the Taxonomy categories on one dimension, the five Guilford Operations on a second dimension, and four Content categories on a third dimension. Two hypotheses are presented: (1) that the Taxonomy categories are factorially complex with respect to the structure of intellect model; and (2) that the six Taxonomy dimensions could be accounted for in most achievement tests by perhaps no more than 20 factors.

Miholland, John E. Measuring cognitive abilities. In McKeachie, W. J., Isaacson, R. L., and Miholland, J. E. Research on the Characteristics of Effective College Teaching. Ann Arbor, University of Michigan, 1964.

The Committee on Criterion for the First Course, of the Division in Teaching of the American Psychological Association has utilized the Taxonomy in the generation of objectives and in the classification of items for a criterion test. Subtests which were designed to measure various types of objectives were developed in an attempt to identify differential patterns of achievement. A factor analysis of the subtest data provided little evidence that the subtest scores represent the objectives they were designed to measure.

Miller, Alice T. Levels of cognitive behavior measured in a controlled teaching situation. Unpublished masters thesis, Cornell University, 1965.

The cumulative hypothesis of the Taxonomy is tested using the Guttman simplex analysis. Approximately 100 students were tested with items representing the first three levels of the Taxonomy. The correlation matrices yield the general pattern of a simplex. The pattern of the regression weights also is consistent with that expected for the simplex model for the first three levels of the Taxonomy in basic physical and biological sciences.

Morse, Kevin M. Manual for questioning strategies observation system. (Preliminary) Unpublished, Austin: Research and Development Center for Teacher Education, The University of Texas at Austin, 1968.

The Questioning Strategies Observational System makes possible a record of the cognitive levels of teachers' questions and other behaviors related to successful questioning strategy. Included in the system are

categories for recording the manner by which teachers direct questions, the types of responses elicited, and the teacher's reaction to pupil responses. This system, containing 24 categories, includes the six levels of the Taxonomy as the core of the analysis of questioning strategies.

Mouw, John T. Effect of dogmatism on levels of cognitive processes. Journal of Educational Psychology, 1969, 60, 365-369.

This study investigated the effect of dogmatism, as defined by Rokeach's scale, on the first five levels of cognitive processes as described in the Taxonomy. A taxonomy based test developed by Stoker and Kropp (1966) was administered to teacher education students. Persons identified as open-minded on the dogmatism scale tended to increase in the mean performance of tasks as the tasks became more complex or autonomous. Those identified as close-minded tended to decrease in mean performance as the tasks became more autonomous.

New South Wales, Department of Education, Australia, 1966.

Under the direction of Leo F. Hanney the Examinations Committees of the New South Wales Department of Education, Sydney, Australia have used the Taxonomy in constructing School Certificate Examinations, primarily in the area of science. The Taxonomy provides a guide for classifying objectives and suggesting techniques of examining those objectives. Reports on the tests to schools also use the Taxonomy as a model.

Pfeiffer, Isabel L. and Davis, O. L. Jr. Teacher-made examinations: what kinds of thinking do they demand? Bulletin of the National Association of Secondary School Principals, 1965, 49, 1-10.

The taxonomic classification of test items in the semester examinations of 9th grade teachers was studied. Percentage of items in each of the six major categories were compared across courses, ability group levels, and programs of study. In all cases the highest percentage of questions fell into the Knowledge category, with Application second highest. Very few questions were classified into the upper three categories, and these were found primarily in some English courses. It was suggested that teachers should be aware of which cognitive processes they are emphasizing in their test questions, and that there should be more emphasis on the higher objectives for all students in all courses. Also, a study should be made to compare the emphasis of instruction and examination questions.

Pfeiffer, Isabel L. and Hunkins, Francis P. Bloom's Taxonomy: a stimulus to better teaching. Ideas Educational, The Kent State University School, 1965, 3,(2), 11-17.

Two studies which illustrate the usefulness of the Taxonomy in analyzing classroom questions are described. The results of these studies illustrate the need for teachers to analyze test questions for the following reasons: (1) so that proper emphasis is given to all cognitive functions; (2) so that the test will be highly related to the cognitive function the teacher hopes to encourage; (3) so that the teacher realizes that more stimulating questioning is demanded for achieving high quality in the educational process.

Pfeiffer, Isabel L. Teaching in ability grouped english classes: a study of verbal interaction and cognitive goals. Journal of Experimental Education, 1967, 36, 33-38.

Five teachers each of whom taught classes of two different ability levels were interviewed to obtain estimates of their emphases on various cognitive goals. The Taxonomy was used to analyze cognitive goals inferred by items on the teacher-made tests. Findings included the following:

1) Teachers emphasized less complex skills in lower ability classes.
2) Test items revealed differentiation of cognitive goals for different ability classes.
3) Teachers generally indicated that they felt one pattern of cognitive goals was important but tested for another.

Picard, Anthony J. An analysis of the objectives of a first year calculus sequence, a test for the achievement of these objectives, and an analysis of results. Dissertation Abstracts, 28A, 3379.

The cognitive and affective Taxonomies were used as one aid in developing a collection of objectives for a first-year calculus sequence. Ratings were made by faculty members and later by students concerning the importance of objectives, and test items constructed for several of the statements. Results indicated that the group of objectives associated with the Knowledge level of the cognitive domain was achieved more satisfactorily than the objectives associated with either Comprehension or Application.

Plowman, Paul D. What can be done for rural gifted children and youth, California State Department of Education, 1967, mimeographed paper.

Subcategories and categories of the Taxonomy are suggested as useful variables for planning individualized and small group instruction. Listed as higher intellectual skills are the subcategories of translation, interpretation and exprapolation as well as the categories of Application, Analysis, Synthesis and Evaluation. It is suggested that these variables, along with others, be examined when planning educational objectives, classroom dialogue, assignments, criteria for developing curricular materials and examination questions.

Plowman, Paul D. An interpretation of the taxonomy of educational objectives, 1968, copyrighted monograph.

This monograph reviews the development of the Taxonomy as a conceptual educational tool and discusses its present and possible future uses. Questions and activities illustrative of each of the taxonomic levels are included. Projected application of the Taxonomy to the preparation and selection of classroom materials and to the appraisal and accredidation of programs, schools, and institutions of higher education is covered.

Pollock, Marion B. The construction of an evaluation instrument to appraise behavior in the use of stimulants and depressants. Dissertation Abstracts, 1967, 27B, 2755.

Instructional objectives, inferred from appropriate content, were formulated according to Taxonomy classifications of cognitive behavior related to Knowledge, Comprehension, and Application. These objectives were then used as the framework for the development of a pool of 120 five-option, multiple-choice items which were utilized in the construction of the instrument. It was concluded that use of such objectives as the source of a representative pool of items was a valid process for the construction of improved health education tests.

Popham, W. James and Baker, Eva L. Curriculum principles for prospective teachers. Teacher Education Quarterly, 1965, 22, 38-41.

Two groups of prospective secondary school teachers were exposed to different approaches to principles of curriculum construction. One group (1) studied a five point rationale suggested by Tyler for selecting instructional objectives; the other group (2) studied principles based on the Taxonomy. One prediction made by the investigators was that group two would select a greater proportion of objectives classified at higher levels of the Taxonomy. The data did not substantiate this prediction. The study in general indicated that the brief exposure to certain curriculum principles did result in some differences in the selection of objectives by the two groups.

Robinson, James T. Understandings of BSCS biology students as determined by instructional tests, Cooperative Research Project No. 1969, Office of Education, U. S. Department of Health, Education and Welfare.

This study was designed to provide a framework within which teachers could work cooperatively to develop specific goals of instruction and then to consider approaches to evaluation which might assess various levels of understanding attained by students. The construction of instructional tests included categorization of items according to Taxonomy categories in order that tests be designed, where possible, to assess understandings beyond recall.

Roe, P. E. Application of Bloom's Taxonomy to Geography, Ongoing project of Yorkshire Regional Examinations Board, Yorkshire, England.

Work is in progress by the Yorkshire Regional Examining Board concerning the application of the Taxonomy to the field of Geography. Teachers responsible for constructing the Certificate of Secondary Education examination will

receive a description of Taxonomy categories with test items illustrative of each. Present thinking is that questions representative of the upper three levels (Analysis, Synthesis and Evaluation) may be too difficult for CSE candidates.

Romberg, Thomas A. and Kilpatrick, Jeremy. Preliminary study on evaluation in mathematics education. Leland Stanford Junior University, 1966 (mimeographed report).

A seminar group listed objectives of Mathematics education for grades K-12 and wrote sample test questions to illustrate the various topics in the curriculum. The first step involved the identification of basic Mathematics topics which pupils are expected to master at each grade level. The topics were then classified according to the Taxonomy categories. A set of 50 test items classified according to content and behavioral skills are presented to illustrate the various levels of the Taxonomy by topic in the curriculum.

Romberg, Thomas A. and Wilson, James W. The development of mathematics achievement tests for the national longitudinal study of mathematical abilities. The Mathematics Teacher, 1968, 61, 489-499. Also published as Romberg, Thomas A. Leland Stanford Junior University, 1966 (mimeographed report).

Content validity was a concern in the development of Mathematics achievement tests. Units of subject matter were identified and the behaviors included in each unit were classified using the Taxonomy as a starting point. The resultant matrix of Mathematical behaviors served as a table of specifications for test construction procedures.

Sanders, Norris M. Classroom Questions, What Kinds?, New York: Harper and Row, 1966.

The basic ideas underlying this volume come from the Taxonomy. A taxonomy of questions, which is structured along the subcategories of the Taxonomy, is suggested as a tool to improve the intellectual climate of a classroom. This taxonomy of questions may provide a useful standard for the selection and evaluation of instructional materials and may suggest hypotheses for educational research.

Chapters two through eight, which are entitled memory, translation, interpretation, application, analysis, synthesis and evaluation respectively, define and illustrate questions for each category. Sample questions are from the field of Social Studies. The last chapter contains suggestions for composing questions.

Scannell, Dale P. and Stellwagen, Walter R. Teaching and testing for degrees of understanding. California Journal of Instructional Improvement, 1960, 3, (1).

The Taxonomy was used to classify both educational objectives and test items. Objectives and final examinations were collected from high school Chemistry teachers in order to compare the relationship between the statement and the measurement of the objective.

Findings include:

1. Over 50 percent of the objectives and 60 percent of the test items related to accumulation of knowledge.

2. Very seldom were students required to exhibit complex cognitive skills (understanding of various degrees) on final examinations.

3. There was seldom a direct relationship between the levels of stated goals and the levels of required examination behavior.

Schaff, John F. "Assessment of the cognitive ability 'evaluation' in students of conventional and modern high school chemistry." Unpublished doctoral dissertation, Florida State University, 1968. Also, paper presented at the meeting of the National Council on Measurement in Education, Minneapolis, March, 1970.

Students given instruction within a modern (CHEM) and a conventional chemistry curriculum were compared using tests based on the behavioral descriptions of the Taxonomy. An instrument was designed to measure the cognitive abilities of Knowledge and Evaluation.

Schmadel, Elnora. The relationship of creative thinking abilities to school achievement. Dissertation Abstracts, 1960, 21, 1964.

The author hypothesized that certain of the creative thinking abilities described by Guilford's "structure of intellect" might contribute to achievement success. Tests of Evaluation and Synthesis, as defined by the Taxonomy were used as one of the achievement measures in a multiple regression model. Low correlations between the scores on these tests and other achievement measures (California Achievement Tests) are reported.

Scott, Harry V. Cognitive analysis of a curriculum: an application of "Taxonomy of Educational Objectives: Handbook I: Cognitive Domain" to "Science--a Process Approach." Dissertation Abstracts, 1967, 27A, 3637.

An analysis was made of cognitive behaviors required by an elementary science curriculum plan, Science--A Process Approach. Behaviors for each activity were categorized according to the Taxonomy. The curriculum plan was found to be systematically progressive in that books for earlier grades tend to

require fewer of the more complex cognitive behaviors than later books. No instances of Evaluation behaviors were found. The author concludes that the Taxonomy can be used in making cognitive analysis of curriculum materials in which expected student behaviors are described.

Scribner, Duane C. Learning hierarchies and literary sequence. English Journal, 1967, 56, 385-393.

The Taxonomy is suggested as one possible aid in determining sequence in literature study in the secondary schools. The author discusses matching principles of literature with the Taxonomy categories to give a general picture of the sophistication of the objectives and an indication of the need for reworking them. It is suggested that the Taxonomy can lead to the identification of a pattern of relative maturity of principles and/or prerequisites.

Scriven, Michael. The methodology of evaluation. Perspectives of Curriculum Evaluation, American Educational Research Association Monograph Series on Curriculum Evaluation, Number 1, Chicago, 1967.

Criteria which should be used in evaluating a teaching instrument are specified in detail using a modified structure of the Taxonomy (cognitive, affective, and motor domains). The Knowledge and Understanding (Comprehension) categories are restructured in an attempt to reduce overlap of factors in the Taxonomy. Conceptual descriptions of educational objectives as well as a manifestation dimension of criterial variables are presented.

Sliepcevich, Elena M. Health education: a conceptual approach to curriculum design. St. Paul, Minnesota, 3M Company Educational Services, April, 1967.

A conceptual model for Health education (grades K-12) includes a classification of goals into three domains — cognitive, affective, and action. The classifications for the cognitive and affective domains were taken from both the Bloom and Krathwohl Taxonomies.

Smith, Richard B. An analysis of scalability of the 'knowledge' and 'comprehension' levels of the "Taxonomy of Educational Objectives: Cognitive Domain." Paper presented at the meeting of the National Council on Measurement in Education, Chicago, February, 1965.

The Knowledge and Comprehension categories of the Taxonomy were used as the basis for generating multiple-choice items dealing with five basic Educational Psychology concepts. Item analysis indicates a general but not perfect scaling of difficulty levels as one proceeds through the Knowledge category. Examination of the intercorrelations of the subclasses of the Knowledge and Comprehension categories failed to yield a hypothesized simplex.

Smith, Richard B. An attempt at constructing scalable sets of test items in the physical sciences. Paper presented at the meeting of the National Council on Measurement in Education, New York, February, 1967. Also, now published as: A discussion of an attempt at constructing reproducible item sets. Journal of Educational Measurement, 1968, 5, 55-60.

The reputed hierarchical categories of the Taxonomy are utilized in an attempt to develop scalable sets of test items in the physical sciences. Item sets consisted of seven or either multiple-choice items which attempt to build upon one another so that each succeeding item required all the knowledge and

processes of the preceeding item plus a little more. Sample sets of items are presented and discussed in reference to the above criteria. Problems were encountered in trying to construct multiple-choice items for the Application, Analysis, and Synthesis categories.

Smith, Richard B. and Paterson, John. A measurement problem in action research. Unpublished manuscript, Purdue University, 1965.

An attempt is made to verify a simple-to-complex continuum at the Knowledge and Comprehension levels of the Taxonomy. A logical progression from "knowledge of terminology" to "extrapolation" from a principle involving the use of the specific term was hypothesized. The results do not support the hypothesis but indicate the lack of relationship between items supposedly dealing with levels of understanding of the same principle.

Stanley, Julian C. and Bolton, Dale L. A review of Bloom's "Taxonomy of Educational Objectives" and J. R. Gerberich's "Specimen Objective Test Items, A Guide to Achievement Test Construction." Educational and Psychological Measurement, 1957, 17, 631-634.

Empirical data is presented concerning (1) the ease or difficulty with which test items can be classified according to the Taxonomy and (2) the levels into which such items fall. Eight graduate students in a class which had studies the Taxonomy for four weeks were asked to classify Gerberich's test items according to the subcategories of the Taxonomy. Results indicate that on one-half of the items, five or more classifiers indicated perfect agreement. Taking into consideration that each item had to be classified into an exact subcategory, the results indicate that the Taxonomy can be used with considerable precision.

Steele, Joe. Things as they are: an evaluation procedure to assess intent and practice in instruction, Unpublished Doctoral Dissertation, University of Illinois, 1969. Also, paper presented at the meeting of the American Educational Research Association, Minneapolis, March, 1970.

A Taxonomy of Intellectual Abilities (TIA) which represents a revision of the Taxonomy is suggested to categorize teachers' stated objectives and their test questions. The TIA was developed as part of an illustrated procedure for the analysis and description of course structure in terms of its internal consistency. Categories in the TIA include Memory, Translation, Interpretation/Extrapolation, Application, Synthesis, Evaluation,and Formal Analysis.

Stevens, Godfrey D. Taxonomy in special education for children with body disorders, Department of Special Education and Rehabilitation, University of Pittsburgh, Pittsburgh, Pennsylvania, 1962.

A broad outline of a tentative taxonomy suited to the central purpose of special education is presented. The outline, which is decimally coded, is clarified by a discussion of each separate element.

Suggestions for using the taxonomy and suggestions which may lead to studies designed to refine the taxonomic structure are presented.

Stoker, Howard. An emerging trend in achievement testing. Florida Journal of Educational Research, 1965, 7, 128-134.

A research project designed as a validation study of the Taxonomy is described. Two major questions investigated were: (1) Can judges agree on the classification of test items into the Taxonomy categories?; and (2) Can empirical evidence be obtained to support the theoretical hierarchical structure of the Taxonomy?

Test items from two standardized tests (reading comprehension and arithmetic computation) were classified by a panel of judges. Results indicate that raters do tend to agree and do tend to classify items congruent with the behaviors the items were intended to evoke.

Experimental tests generated using the Taxonomy categories were administered to 1,000 students in grades 9-12. Results supported the hypothesized order of mean category scores thus providing general evidence for the imputed hierarchical structure of the Taxonomy.

Stoker, Howard W. and Kropp, Russell P. Measurement of cognitive processes. Journal of Educational Measurement, 1964, 1, 39-42.

Two questions are investigated: Can judges agree about the cognitive process which a test item is intended to measure? Can the imputed hierarchical structure of the Taxonomy be empirically validated? Interjudge agreement was found with respect to the classification of test items in the intended category. General support for the hierarchical structure of the Taxonomy is suggested by the data; however, a hypothesized factor structure was not supported by various factor matrices.

Stoker Howard W. and Kropp, Russell P. The hierachy of cognitive processes. Paper presented at the meeting of the American Educational Research Association, Chicago, February 1966.

Specially constructed taxonomy-based tests were administered on the high school level to investigate the imputed hierarchical structure of the Taxonomy. This hypothesized hierarchical structure was examined according to Guttman's simplex theory, the data generally supporting the inverse relationship between

process level mean scores and the level of complexity of the process. Support was thus given to the hierarchical structure and to the construct validity of the specific tests.

Sumner, R. The objectives of craft education. The Vocational Aspect, 1968, 20, (46), 137-149.

It is suggested that all three domains (cognitive, affective and psychomotor) of the Taxonomy provide a conceptual framework which is well suited to the consideration of craft behaviors. Each of the subcategories of the cognitive and affective domains are listed with an example appropriate to craft education. There are also some suggestions provided for a proposed psychomotor taxonomy. It is concluded that such a taxonomic approach can demonstrate how finer conceptual tools lead to the more precise statement of educational objectives.

Turner, M. and Dunn, S. S. Prematriculation Physics Examination, Report No. 2. Australian Council for Educational Research, Victoria, Australia, 1965.

Research involving the Australian Council for Educational Research, Prematriculation Physics Examination included an analysis based upon the levels of the Taxonomy - Knowledge, Application, and Understanding (Comprehension). Results indicate that (a) Knowledge items were less reliable, as a group, than the other type items; and (b) various groups of subjects showed greatest relative differences on understanding type items and smallest differences on Knowledge type items.

Tyler, Louise L. "The Taxonomy of Educational Objectives: Cognitive Domain" — its use in evaluating programmed instruction. California Journal of Educational Research, 1966, 17, (1), 26-32.

Frames in a sixth grade self-instructional program were classified according to the Taxonomy categories. Agreement of raters varied from 63 to 97 percent. The Taxonomy was found to be an efficient tool since 354 frames were classified in only ten hours. The Taxonomy was also recommended as a useful instrument for program evaluation.

Tyler, Louise L. and Okumu, Laura J. A beginning step: a system for analyzing courses in teacher education. Journal of Teacher Education, 1965, 16, 438-444.

The Taxonomy was utilized to classify course materials and examinations for a teacher education program. Findings include: (a) a noticeable discrepancy between course descriptions and actual behaviors required; (b) a considerable emphasis upon Knowledge type behaviors; and (c) a lack of attention given to developing certain important cognitive skills. The Taxonomy provided a useful structure for looking at course behaviors.

Waimon, Morton D. and Hermanowicz, Henry J. Helping prospective teachers classify and study teaching behavior. The Teachers College Journal, 1966, 38, 97-102.

The development of a conceptual system which prospective teachers could use reliably in the study of teaching behavior is discussed. This study of teacher-learner behavior proceeded through three stages: (1) classifying teacher behavior; (2) classifying pupil responses; and (3) classifying teaching episodes. An adaptation of the Taxonomy into three levels (knowledge, comprehension, reasoning) was used in stage two as a basis for classifying the magnitude of pupil response.

Wasik, John L. The validation of the Taxonomy processes of synthesis and evaluation. Dissertation Abstracts, 1967, 28A, 979-980.

Concurrent and construct validity of the Synthesis and Evaluation processes described in the Taxonomy were investigated. Concurrent validity was determined by the extent to which patterns of student behavior identified as Synthesis and Evaluation agreed with student performance on tests constructed to measure these Taxonomy processes. The construct validity was investigated by relating student performance on the Taxonomy measures to a battery of measures selected to sample abilities of the Guilford "structure of intellect" model which were thought to be logically related to the Taxonomy processes.

Wildman, Peggy R. The fallacy of facts. Peabody Journal of Education, 1966, 44, 177-180.

Teachers are urged to produce a classroom environment less concerned with facts and more conducive for problem solving and independence of thought. The author suggests the Taxonomy as the most promising model for evaluation of teaching objectives, and briefly describes the six major taxonomic levels.

Wilhoyte, Robert L. Problems of meaning and reference in Bloom's Taxonomy: Cognitive Domain. Dissertation Abstracts, 1966, 26, 6569.

The organization and internal structure of the Taxonomy was examined. An attempt was made to resolve the dilemma of whether the Taxonomy's logical arrangement restricts the very objectives from which it is supposed to be generated. It was concluded that the empirical ground of the Taxonomy

is weak since the data to be classified are teacher-intended student behaviors while the class and subclass terms refer to actual student performance. However, if teacher intentions are based on actual events rather than intuitions and personal preferences, then the terms are less prescriptive. Finally, if significance is retained and formulated as definiens of verbal definitions, then the abstracted Taxonomy is verifiable and efficacious.

Wood, Jean M. A survey of objectives for teacher education. Prepared for the Commission on Teacher Education, Association for Supervision and Curriculum Development. San Bernardino City School System, San Bernardino, California, 1960.

The Taxonomy was used to classify educational objectives of teacher training institutions as stated in the 1959 catalogues of colleges and universities accredited by the National Council of Accreditation of Teacher Education. The distribution of objectives in each major category is presented with 200 of 369 objectives falling in the Knowledge category.

Wood, R. Objectives in the teaching of mathematics. Educational Research, 1968, 10, 83-98.

The purpose of this article is to review various sets of objectives in Mathematics teaching which people have found useful in clarifying and arranging their thoughts. Considerable attention is given to the Taxonomy as being especially applicable to the field of Mathematics where most significant behaviors appear to have cognitive origins. Other classification schemes useful in analyzing instructional objectives are discussed in a quite thorough way. The list of 32 references is valuable for anyone interested in curriculum building in Mathematics. Especially inter-

esting is the reporting on what kind of thinking about this problem is being done in countries other than the United States.

Wyckoff, D. Campbell. The import of the "Bloom Taxonomies" for religious education. Religious Education, 1968, 63, 478-484.

After summarizing the cognitive and affective Taxonomies, the author suggests applications to the field of religious education.

Zinn, Karl L. Validation of a differential test of cognitive objectives of the first course in psychology. Dissertation Abstracts, 1964, 25, 3413.

Primary concern in this study is with the empirical differentiation of measures of achievement in the cognitive domain, for instance, differentiation of scores on tests labeled interpretation, application, analysis and evaluation. The test used in the study was initiated by the Committee on Criteria of the First Course of the Division on Teaching of the American Psychological Association and was developed along the lines of the Taxonomy. Findings advise a conservative interpretation of the results of differential tests of achievement representing such general cognitive objectives.

Zinn, Karl L. The uses of the Taxonomy and computer assistance in assembling sets of objectives, test items, and diagnostic test sequences. Paper presented at the meeting of the American Educational Research Association, Chicago, February, 1966.

The author covers several areas of research interest to him which involve the Taxonomy. His review of other taxonomic classifications has led him to suggest a domain of taxonomies which includes dimensions of purpose of language and referents for the language. Several adaptations of the Taxonomy for use in the construction of classroom tests are reviewed and a computerized approach suggested to aid instructors in developing behavioral objectives. A procedure involving the computerized assembling of test items and generation of test sequences is presented as a means of examining the differentiability of achievement scores based on the Taxonomy.